Space Weather Technical Forecast

Issued on Monday, 03 April 2023 at 00:29 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of Minor Geomagnetic Storms Days 1-3. Periods of Active electron fluence expected.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with several small C-class flare observed. The peak being a C3.4 flare at 02/2313 UTC from newly numbered AR3270. There are currently four numbered sunspot regions on the disc. Most are small and simple with little magnetic complexity. However, newly emerged AR3270 has grown fairly rapidly and contains a number of small intermediate spots of opposing polarity in relatively close proximity. The analysis and modelling of Coronal Mass Ejections (CMEs) detected in available imagery over the past 24 hours suggest no Earth-directed component.

Solar Wind / Geomagnetic Activity: The solar wind, as measured at L1 by ACE and DSCOVR, has been predominantly Elevated, with wind speeds initially 530-580 km/s due to the ongoing enhancement from Coronal Hole 88/-. Later in the UTC day on the 2nd, speeds dropped to Slightly Elevated levels (around 480km/s) suggesting waning influence of this feature at Earth. Density was below average throughout and the phi angle was mostly negative (towards the Sun). The IMF was weak (below 8nT), with fluctuations between +6/-6nT in the north-south component. Geomagnetic activity was initially Active (Kp4) but reduced to Quiet to Unsettled (Kp0-3) levels from 02/0600 UTC.

Energetic Particles / Solar Radiation: High energy proton enhancement (greater than 10MeV) has been at background levels.

The high energy electron flux (greater than 2MeV), as measured at GOES16 has varied diurnally between Normal Background and mainly Moderate levels, but with a short-lived peak to High levels (1.07e3 pfu) at 02/0405 UTC. The associated 24-hour fluence was above the Active (1e8 integrated pfu) threshold to start the period, with a steadily decreasing, then flat trend back to Normal Background levels. At 03/0001 UTC the observed fluence was 4.29e7 integrated pfu was recorded at 03/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain Low, with a Slight Chance of increasing to Moderate levels.

Solar Wind / Geomagnetic Activity: Although no Earth-directed CMEs are expected, there is a very slight chance of glancing blows from one or more CMEs at Earth on Days 1 and 2 (03 and 04 Apr).

Solar winds are currently at Elevated to Slightly Elevated levels. Wind speeds are likely to become predominantly Slightly Elevated on Day 1 (03 Apr), although this may be complicated by any transitory CME impacts. On Days 2-3 (04-05 Apr) Earth is expected to connect to the HSS from one or more coronal holes. Solar wind speeds are expected to return to Elevated or perhaps Strong levels and continue into Day 4 (06 Apr).

Generally Quiet to Unsettled geomagnetic activity is expected on Day 1 with a chance of Active intervals or perhaps isolated G1/Minor Storm conditions, particularly should any CME effects occur. There is an increasing probability of Active or G1/Minor Storm intervals on Day 2 due to the combined influence of coronal hole HSS and possible transitory CME effects. Activity should

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generally ease to Unsettled levels by Days 3 and 4 with a reducing risk of Active or G1/Minor Storm conditions in the absence of any further CMEs.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as observed by GOES-16 is at background levels and is expected to remain so pending any significant sunspot development.

The flux at GOES16 is at Moderate, but near to High levels to start the period. As Geomagnetic activity wanes on Day 1 (03 Apr) it is likely that diurnal fluctuations in electron flux will reach High levels again. There is a very slight chance that CME influences could suppress observed flux values temporarily back towards Normal Background, adding uncertainty into the forecast early in the period.

As the HSS from one or more coronal holes affects Earth from Day 2 (04 Apr) and perhaps also a glancing blow from another CME, it is likely that flux values should return to Normal Background levels for a period. Electron counts would be expected to rise again into Day 4 (06 Apr) as geomagnetic activity likely subsides, bringing an increased chance of High electron flux levels being reached.

Confidence in electron fluence levels is lower than usual given the uncertainty in any CME and HSS impacts during the period. Fluence levels are currently just below the Active threshold, but are expected to increase to Active levels on Day 1 and likely persist early on Day 2, ahead of any reduction due to the onset of one or more coronal hole HSS. Electron fluence may then reach Active levels once again on Day 4 as Geomagnetic activity subsides.

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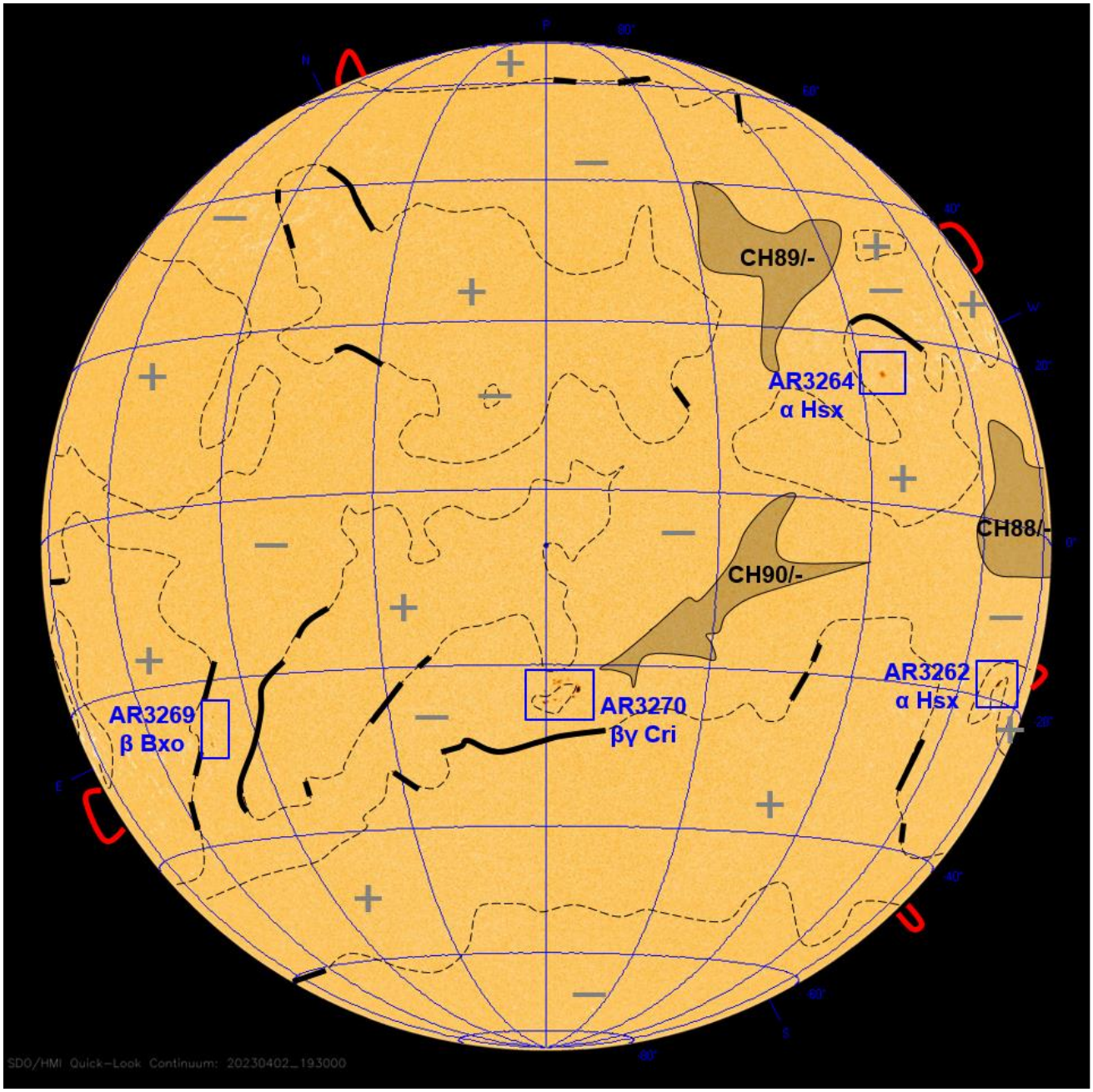
Figure 1. Solar Analysis Valid 02/1930 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There have been a number of generally small, but complex to analyse CMEs over the last few days. Although modelling would suggest that these are not Earth-directed, there remains a very slight chance of glancing blows arriving at Earth on Day 1 and 2 (03 and 04 Apr), supported by a small number of MOSWOC ENLIL ensemble perturbations.

Solar winds are currently at Elevated to Slightly Elevated levels, a result of the ongoing (but waning) influence of a HSS from CH88/-. Wind speeds are likely to become predominantly Slightly Elevated on Day 1 (03 Apr), although this may be complicated by any transitory CME impacts. On Days 2-3 (04-05 Apr) Earth is expected to connect to the HSS from Coronal Holes 89/- and/or 90/-, with CH90/- in the southern hemisphere expected to be the dominant feature. Solar wind speeds are expected to return to Elevated or perhaps Strong levels and continue into Day 4 (06 Apr). Enlil appears to be modelling this well.

Generally Quiet to Unsettled geomagnetic activity is expected on Day 1 with a chance of Active intervals or perhaps isolated G1/Minor Storm conditions, particularly should any CME effects occur. There is an increasing probability of Active or G1/Minor Storm intervals on Day 2 due to the combined influence of coronal hole HSS and possible transitory CME effects. Activity should generally ease to Unsettled levels by Days 3 and 4 with a reducing risk of Active or G1/Minor Storm conditions in the absence of any further CMEs.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	40	20	5
Strong	G3	No	1	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections – Nil expected

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Radio Blackouts - X-Ray Flares:

The four-day forecast period is currently expected to see a fairly muted flare risk due to the presence of a small number of generally simple regions on the visible disc. AR3270, however, will continue to be closely monitored and further development could see an increase in significant flare probabilities in the short-term.

There is a signal for returning or new regions to potentially arrive across the eastern limb during the period. Soundings suggest the most active of these regions may emerge in the northern hemisphere on Day 2 or 3 (04 or 05 Apr) with an associated minor uptick in forecast flare risk.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	10	15	15	15
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV), as observed by GOES-16 is forecast to remain at background levels, pending any significant sunspot development.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):

The flux at GOES16 is at Moderate, but near to High levels to start the period. As the influence of the HSS from CH88/- continues to wane on Day 1 (03 Apr) it is likely that diurnal fluctuations in electron flux will reach High levels again. There is a very slight chance that CME influences could suppress observed flux values temporarily back towards Normal Background, adding uncertainty into the forecast early in the period.

As the HSS from CH89/- and/or CH90/- affects Earth from Day 2 (04 Apr) and perhaps also a glancing blow from another CME, it is likely that the electron belts will be compressed and flux values should return to Normal Background levels for a period. Electron counts would be expected to rise again into Day 4 (06 Apr) as geomagnetic activity likely subsides, bringing an increased chance of High electron flux levels being reached.

Confidence in electron fluence levels is lower than usual given the uncertainty in any CME and HSS impacts during the period. Fluence levels are currently just below the Active threshold, but are expected to increase to Active levels on Day 1 and likely persist early on Day 2, ahead of any reduction due to the onset of one or more coronal hole HSS. Electron fluence may then reach Active levels once again on Day 4 as Geomagnetic activity subsides.

MOSWOC REFM forecast is currently over-forecasting fluence levels, though the general trend during the period is thought to be a reasonable guide for the coming days.

GEO Electron Environment	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	80	60	20	50
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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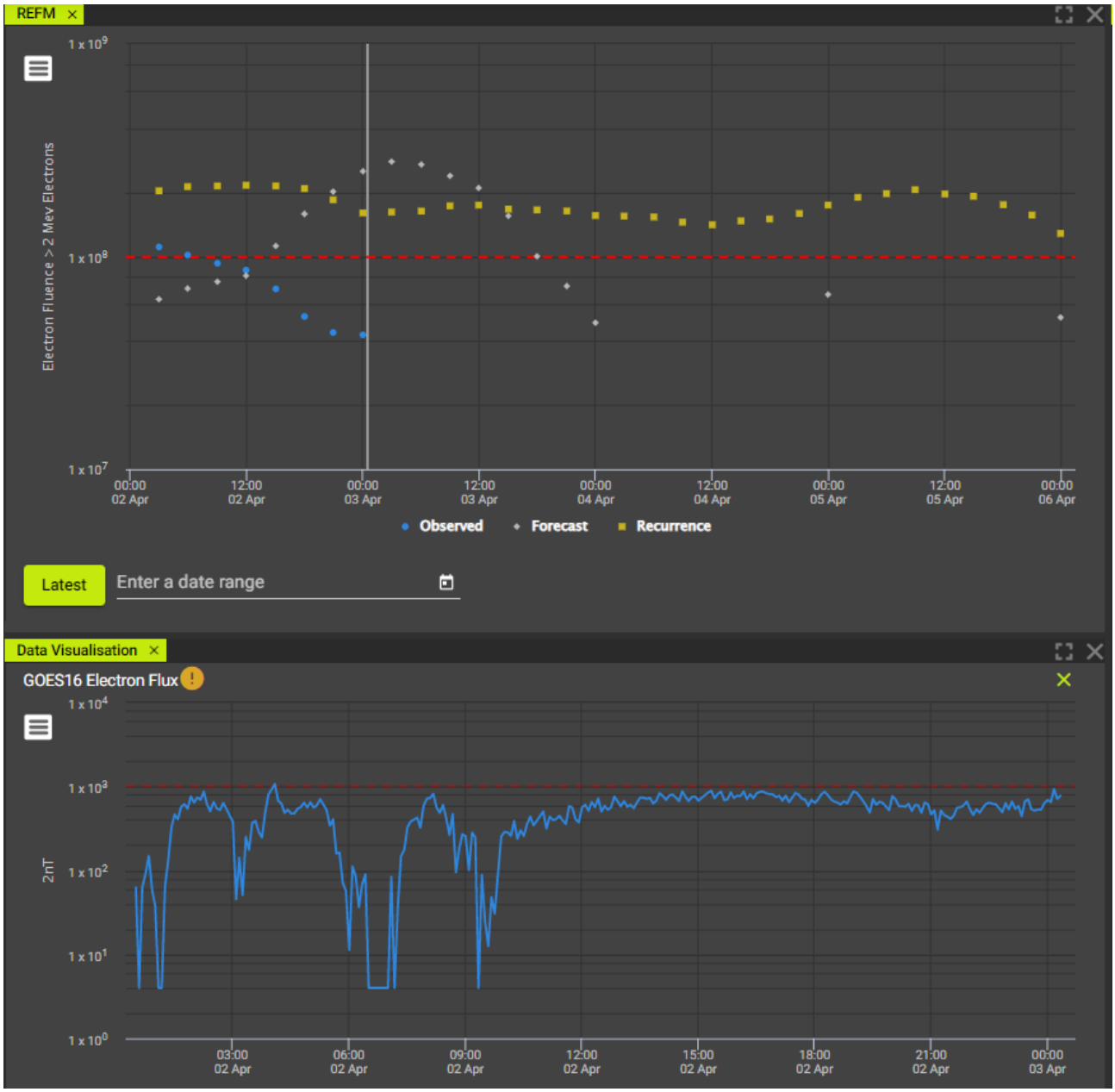
Figure 2: MOSWOC REFM output and GOES-16 electron flux



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